Requirements for Minor Subdivision of GCDB Parcels:
Jan. 16, 2004

Purpose of Document

This document provides requirements for writing a software application to automate the further division of 40 acre parcels within the GCDB data, based on stored land descriptions existing in the LR2000 data bases. The result of these subdivisions will be the core instructions for the continued reconstruction of minor subdivision parcels during each cycle of maintenance of the surveyed data.

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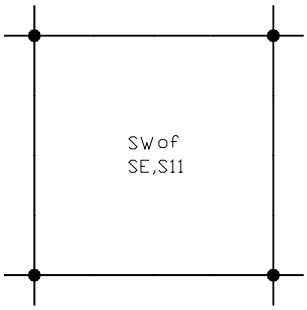
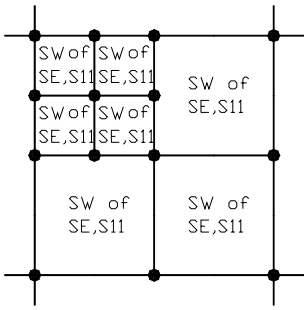
1. Background:

Need for Minor Subdivision Explained: The land records of the BLM contain units of land that are administered as aliquot pieces below the 40 acre parcel level. These divisions below the 40 acre parcel level are known as "minor subdivision". Many entries in the LR2000 databases such as Case Recordation and Land Status contain full legal descriptions of known parcels well below the 40-acre level. The Legal Land Description (LLD) system adopted a data format that could only describe land location to the 40-acre level. The attributes for legal land descriptions have been assigned to GCDB parcels, employing the LLD format, even though the GCDB software is capable of creating and displaying land boundaries to any level of detail. However, because the labeling (attribution) has been based on the LLD format, GCDB currently labels polygons with a nominal location code at the 40-acre level. These historic limitations of GCDB attribution can be eliminated if GCDB extends its data structure to incorporate aliquot part descriptions to a much more granular level.

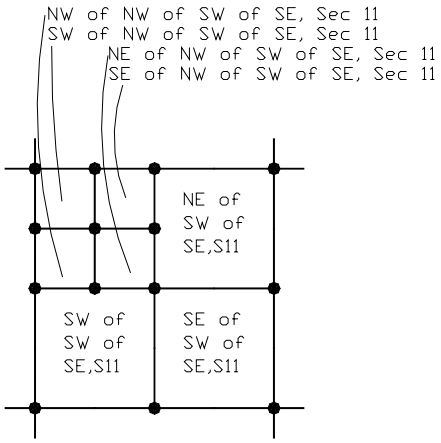
State of GCDB Data: Some staffs subdivide only to the 40-acre level, anticipating that a minor subdivision function will become available which will ensure a direct link between GCDB and LR2000's Case Recordation. See GCDB Case 1 in Fig1-1, below. Other GCDB staffs have taken the time-consuming task of subdividing sections to the level shown on the Master Title Plats, even though these minor subdivision parcels could not be attributed to a level of detail lower than forty acres. See GCDB Case 2 in Fig1-1, below.



GCDB Case 1, no spatial for for known minor subdivisions



GCDB Case 2, spatials for minor subdivisions collected, all attributes identical



Desired result, spatial data collected, attributed

Synopsis of Needed Functions: An application for performing minor subdivision needs to be written which will read LR2000 land records, on a section-by-section basis and extract the description of each minor subdivision parcel. A report will then be created to store this data into a specific file format. The functionality of this extraction process is described in Section 2, below. Using the description of each minor subdivision parcel as a guide, the GCDB data as it exists must be interpreted to discern what further section subdivision needs to be performed. Any newly created points will need a unique GCDB point identifier. Minor subdivision parcels must be described with a unique identifier, such as the N½ NW¼ SE¼ NW¼, of Section One, Township Eleven North, Range Ten West, New Mexico, including those parcels that have been previously divided spatially and not yet attributed to the needed detail.

Because many of the minor subdivision parcels have never been produced spatially, an automatic process will need to be devised, which creates the points, lines and land area descriptors to a detail necessary to display those legal land descriptions found in the LR 2000 data bases. The geometric processes needed to accomplish this division could optionally be stored for later use when performing future maintenance and updates.

2. Converting Minor Subdivisions from LR2000 Descriptions to a Deaggregated Format. Note: This work has already been done by LR2000 staff.

2.1 - Extraction of Minor Subdivisions from Case Recordation: The minor subdivision descriptions in the Case Recordation database must be extracted.

Example: A parcel is described in Case Recordation as: SESWSW in Sec01, SWSES2 in Sec01, NWNEE2 in Sec12, and NENWNW in Sec12, and NWNENWE2 in Sec12 would appear spatially as seen in Figure 2-1, at right.

In this document, a minor subdivision description would be the "NWNEE2 of section 12". The parcel to the right has five minor subdivision descriptions that aggregate into a single parcel description.

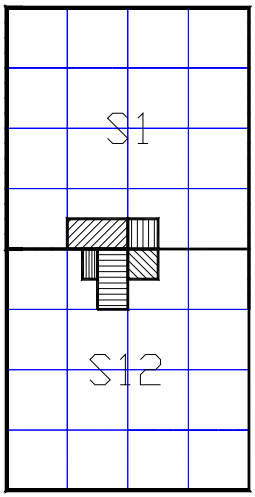


Figure 2-1

2.2 - Convert each "1/2" aliquot descriptions to two "1/4" aliquot descriptions. Refer to the following Figure 2-2, which is a detail of the NW ¼ of the NE1/4 of Section 12 from Figure 2-1.

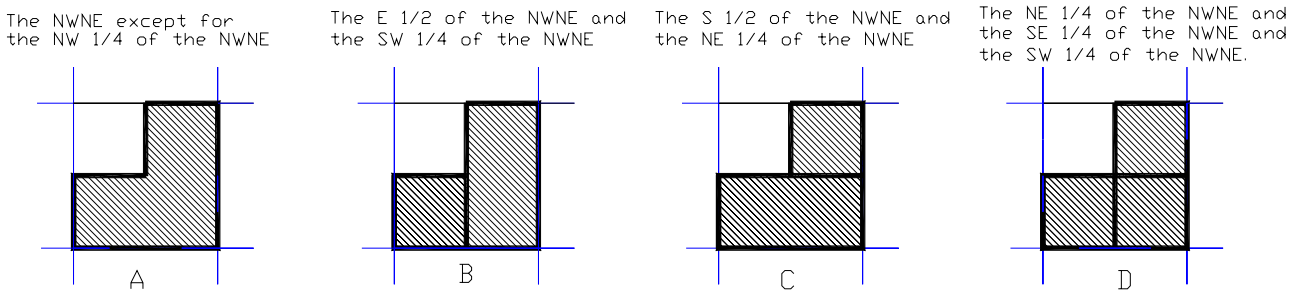


Figure 2-2 The "NW ¼ of the NE ¼ of Section 12 has been abbreviated to "NWNE"

All four sketches (A-D) are of the same parcel, but described in different ways. Because of the complexities of trying to get any query to recognize these descriptions as the same parcel, it is considered the best strategy to redescribe the aggregated types (A-C) into the deaggregated style (D). The GCDB data will be densified to display and label the polygon elements in their deaggregated form. It is the job of the Parcel Management to aggregate these elemental polygons to match parcel descriptions.

3. Divide the spatial elements of GCDB to match the minor subdivision descriptions

3.0) Update the GCDB COGO Constructions. After extracting a list of the deaggregated (2.2) descriptions of the known minor subdivisions from the LR2000 it will be necessary to use this report to update the spatial representation of these parcels in the GCDB. This update can be performed on a section-by-section basis, or even a 1/16thsection-by-1/16thsection basis, and there is a logical order to follow for the editing of each description, as the following steps outline:

3.1) Select a minor subdivision description from the report of minor subdivisions in LR2000.

Within any aliquot piece, select the description with the largest area; take care of all the 10 acre descriptions before moving to the 2.5 acre descriptions. For example, solving for the NE¼ of the NENW of Section 12 (refer to Figure 2-1), will automatically create the points/lines necessary to describe the SE¼ of the NENW. It will also create the NW¼ of the NENW so that it will only be a one-stage process to then solve for NE¼ and the SE ¼ within that NW¼.

3.2) Search for any polygons that spatially define the selected description.

Identify the polygon that encompasses the 40-acre nominal location parcels using the GCDB point ID scheme as a guide. After delineating a particular nominal parcel, save a list of all existing points and lines on or inside this polygon

For points defining 1/64ths and 1/256ths this is done by studying the point/line locations and point IDs. Example: The sequence of GCDB point IDs 640600-640610-650610-650600-640600 describes the "SESWSW in Sec01" shown in Figure 2-1.

On certain offset 1/256th corners where a point ID prefix and suffix are not multiples of 5 and for all 1/1024th corners, the function of the corner must be determined by its spatial relationship to the adjacent controlling aliquot corners. The data to search for this relationship is either found in:
1) the measurement data. Ex. 420610-420613 2.5chs North, 420613-420615 2.5chs North. OR
2) the point construction data. Ex. Create 420613 at midpoint of the straight line 420610-420615. Refer to Figure A-4, below

3.3) Create any COGO instructions to build the points and lines necessary to display the selected minor subdivision description.

Determine and save to memory a list of the necessary point IDs and lines that will be necessary to accomplish subdivision to the required level of detail.

Search list of known point IDs for needed ID. If points are not found, divide polygon into quarters. Calculate midpoint coordinates along all four sides of the aliquot parcel according to midpoint instructions in Appendix C. Create a "center" corner at intersection of the two lines connecting the midpoints according to intersection instructions in Appendix C.

Appendix A - The GCDB Point ID naming convention

The GCDB ID has 6 characters formed by two pairs of 3 character values. Currently these values are entirely numeric. If the first three characters (prefix) of a point's ID are between 100 and 711 then those characters describe the point's position from West to East, within the township, and the rightmost three characters (suffix) describe the point's position, from North to South, within the township. If the first three characters are greater than 711 then the point is a special survey point, not applicable to subdivision, and is irrelevant to this discussion.

Each three-character part of the ID breaks down with very simple rules.

Point IDs for dividing a township into sections

Below is an example of a typical township with standard point IDs assigned to all section corners. The grid of seven North-South, and seven East-West lines has been constructed. The prefixes of the North-South lines begin with the number 100, on the western-most line, and increase in 100 unit increments as the lines proceed easterly, to the eastern-most line, which is identified by the prefix of 700.

The seven East-West lines begin with a suffix of 100, at the southern-most line in the township and increase in 100 unit increments, to the northern-most line, which is identified by a suffix of 700.

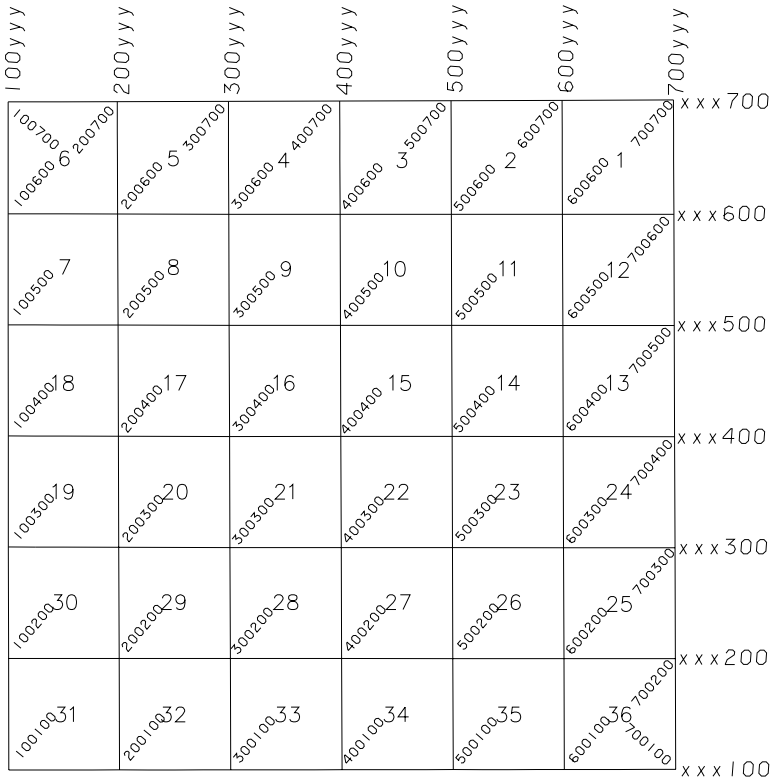


Figure A-1

Point IDs for dividing a section

S The second character divides the section line into 8 portions of 10 chain distances, or down to the 1/64th corner level. The values are from 0-7, where 0 is on the section line and 7 is 10 chs from the next section line.

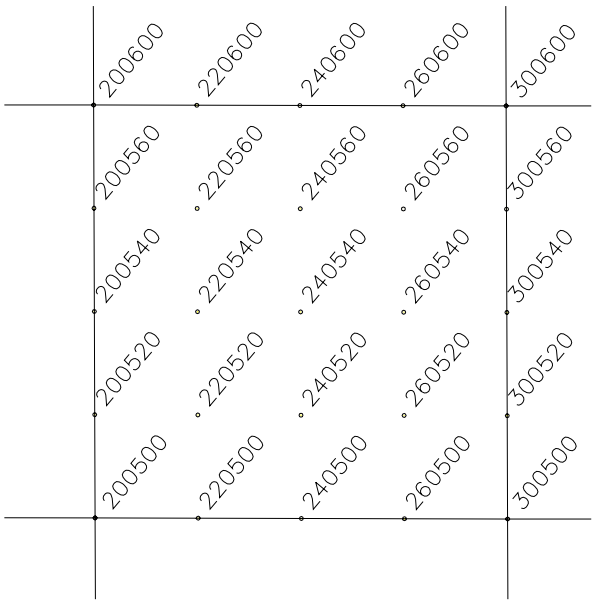


Figure A-2, GCDB IDs for Section 8

Point IDs for dividing a 40 acre aliquot piece.

S The third character divides the 10-chain segment into further divisions. The value of 0, 1, 9, 2 or 8 indicates a 1/64th, 1/16th, 1/4 or section line. A value of 5 can indicate a 1/256th corner. Any other numbers can be used for further division. If there are not enough numbers, which could occur along "offset" lines, then arbitrary numbers can be used. Refer to Figures A-3 and A-4, below.

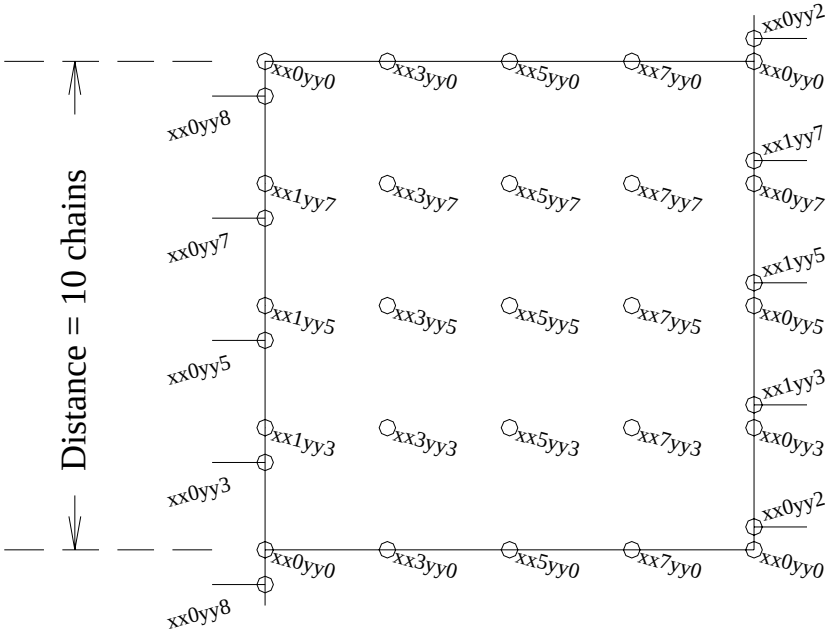


Figure A-3, GCDB ID scheme for Minor Subdivision

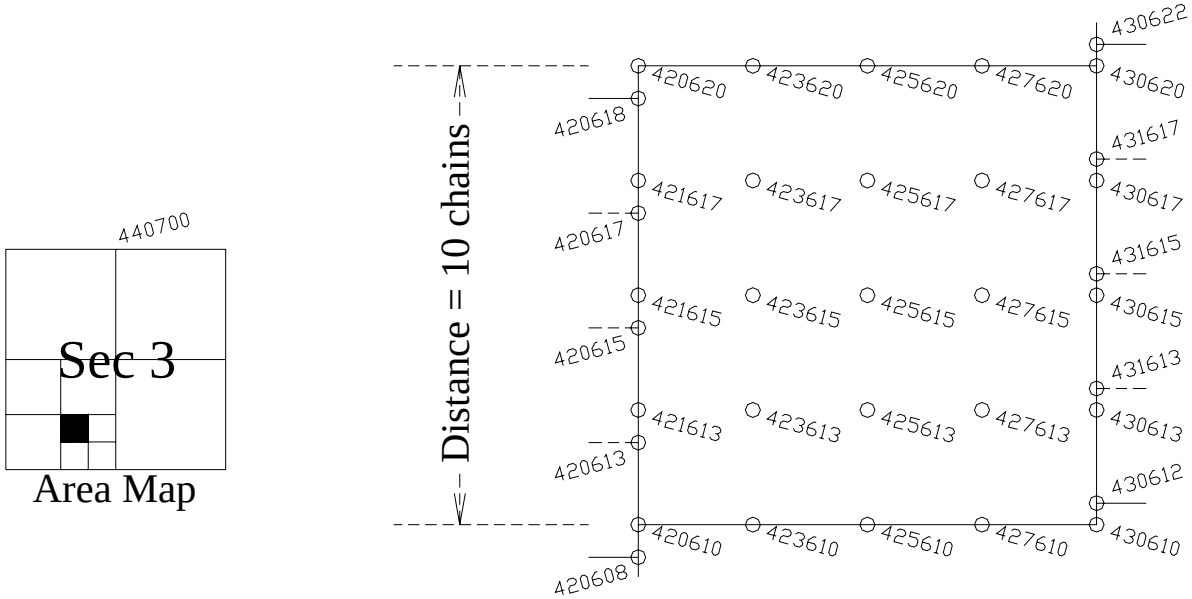


Figure A-4, GCDB ID example for NW ¼ of SE ¼ of SW ¼ of Section 3.

Appendix B - GCDB File Formats - The GMM .ADD file format

The .ADD file content below pertains only to COGO construction data for minor subdivision. Other variances exist in the .ADD file, but the content need not be understood by minor subdivision, just preserved.

```
 1 440670 440660 440700    .00000  1      .000      .000
 2 950105 500300 520300    .00000  2      .000      .000
 0      0 901030 901045    .00000  2      .000      .000
 3 170400 170410      0    .00000  0      .000      .000
.....................................................
12345678901234567890123456789012345678901234567890123456
         1         2         3         4         5
```

Column 02: Construction method.
- "1" indicates midpoint/proportion/traverse. We are only concerned with midpoint calculations when producing minor subdivision parcels, not the proportion or traverse calculations.
- "2" indicates the 1st of 2 lines needed to describe an intersection. This line describes the 1st line.
- "0" indicates the 2nd of 2 lines needed to describe an intersection. This line describes the 2nd line.
- "3" indicates add a line between two points. This will be used with minor sub codes V, W, X, Y.

Columns 04-09: Point ID of point being generated. A value of "0" means not applicable.

Columns 11-16: Point ID of controlling corner, at the beginning of the line. ("from")

Columns 18-23: Point ID of controlling corner, at the end of the line. ("to")

Columns 25-33: Not applicable to minor subdivision.

Column 36: Plane/Geodetic code:
- "1" indicates computations were made using plane geometry (usually corners in section interior)
- "2" indicates computations were made using geodetic geometry (usually on section boundaries)
- "0" indicates no computations were made (used with method code 3 - "Add a line")

Columns 38-46: Not applicable to minor subdivision.

Columns 48-56: Not applicable to minor subdivision.

Note: Order of entries in the ADD file is irrelevant.

Appendix C - Calculation of midpoints and intersections and add-a-line

There are three major geometric processes involved in creating minor subdivision parcels, they are: creating midpoints, creating intersection points and adding lines.

Midpoint: Midpoint is at mean distance "along the boundary", and not necessarily the average of the coordinates of the two polygon corners. There may be monumented points along the boundary that cause a break in bearing along the boundary.

- If there is no intermediate point along the boundary, then use the arithmetic mean of the controlling coordinates. Example is E ¼ corner in Figure 3-1.

- If there is an intermediate point or points along the boundary, first determine if there is a point at midpoint. (Solid clue: check measurement data. Compare the distances from the intermediate point out to the controlling corners - they should be the same. For example, in Figure C-1, if a = b + c, then the N¼ corner is at midpoint. (Another solid clue: check COGO construction data (.ADD file). If a point is created at midpoint along the boundary, then use that as the solution.

- If the point is at midpoint, then no calculation needs to be made. N ¼ in Fig. C-3.

- If there is no point at midpoint, then determine the line on which to place the midpoint. It is acceptable to calculate the midpoint between the controlling corners (1 and 2 in Figure C-1), then going cardinal from there to the boundary line.

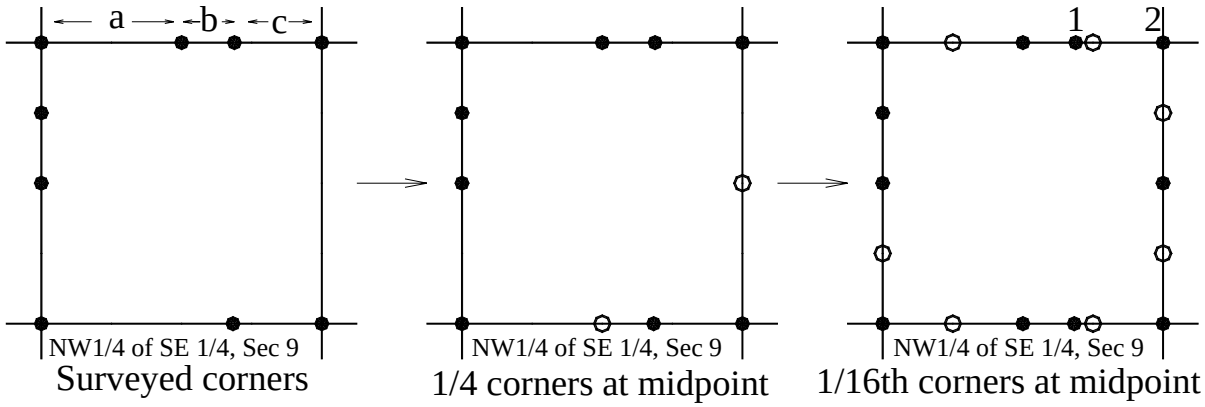


Figure C-1, unknown midpoints are computed in stages.

Very important note about latitudinal lines vs. straight lines.

Section lines and special survey boundaries have different geometric properties than interior subdivision of section lines.

Section lines and other large surveyed features are lines of constant geographic bearing. A due west section line follows the latitudinal curve so calculating midpoints along those lines require non-planar geometry.

Interior subdivision lines, those created by intersection, are straight as in "line-of-sight" and normal algorithms for plane coordinate geometry can be applied. There are some states that direct their surveyors to use the latitudinal lines in their section subdivision. There is a data element in each entry in the ADD file that tracks whether a line is geodetic or plane so that it is clear which algorithm to use. See Appendix B - GMM File Formats, ADD File.

In minor subdivision the difference between plane and geodetic midpoints is negligible. The difference for a 1/64th corner is 0.08 inches in Arizona and 0.14 inches in Montana. For the purposes of this data using plane geometry for calculations is sufficient. It is important when testing for the existence of a midpoint to allow a tolerance in a N-S direction to find midpoints that were put on the geodetic line.

Intersections: Once the midpoints have been determined on all sides of the "parent" aliquot parcel, then the direction (slope) of the centerlines can be determined. Calculate the intersection of the two centerlines. Create a point ID based on point ID rules. Determine the point ID strings that form the boundary of each of the newly-formed child polygons. Calculate the coordinates of the centroid for each newly-formed child polygon.

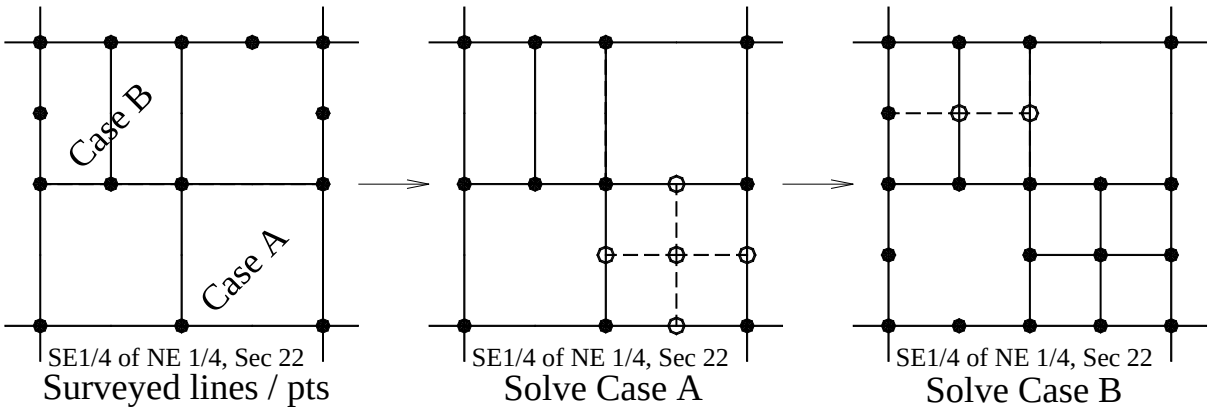


Figure C-2, solving intersections in stages

How GMM subdivision program APROPW.EXE treats data in the ADD file:

APROPW strips all coordinates constructed through the section subdivision process leaving only lines and points that were entered as measurements on survey plat data. Measured lines found in the NOT file are removed from consideration. APROPW reads through the ADD file and creates any points possible, then iterates this step creating points whose parameters were created in earlier iterations. APROPW will ignore instructions to create a point if the coordinates of that point are already known or if the instructions are dependent on points not yet computed. APROPW will create coordinates using plane or geodetic methods based on the plane/geodetic parameter and will calculate the positional reliabilities based on the positional reliabilities of the points used in construction. APROPW tracks line connectivity, replacing parent lines with child lines. Other subdivision processes take place using implicit rules and using data from the .IRR file. The iterative processing of the ADD file occurs again. Line intersection that have no point features are found and point features are created automatically at those line intersections. Any remaining lines in the NOT file are removed from consideration. Coordinate values are stored in several file formats, .PGC, .COR and .GEO. All remaining line sequences are stored in the .LXN file. Polygons are formed with these remaining lines and stored in the .INT file. An additional executable called GETLXW stores coordinate and line data into the LX file.